

Design and fabrication of the electronic modules

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Wireless implantable catheter-type oximeter designed for cardiac oxygen saturation

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Detailed protocol

Procedure:

1. The circuit is designed and implemented using commercial electronic design automation (EDA) software;
2. Laser cutter process the copper-clad polyimide, to generate the flexible printed circuited board (fPCB);
3. Bluetooth firmware is developed on embedded software development platform: Keil uVision5;
4. Solder the electronics components including the Bluetooth microcontroller on the fPCB;
5. A three-dimensional (3D) mold is designed using commercial computer-aided design (CAD) software;
6. The 3D molds are manufactured based on an aluminum plate by a three-axis milling machine;
7. Soft encapsulation silicone is made from Silbione RTV 4420 part A and part B, mixed with 5% of Silc-Pig silicone opaque dye (pink);
8. Films of soft silicone materials are created in the mold by drop-casting, and other films are formed by spin-casting (250 rpm) on glass slides.
9. Both films are thermally cured at 70°C for 30 minutes;
10. Place the fully assembled electronic module into the molded layer; pour a solution of soft silicone to fill the voids in between electronics and the top layer; attach the glass slides with silicone films to the top;
11. Clamp the parts together, and place the entire assembly into a 70°C oven, curing for 30 minutes;
12. Take out the encapsulated module;
13. A final cutting process with a CO₂ laser defines a smooth perimeter boundary for the system;
14. A manual cutting process with a small blade define openings for the connector and switch;

Images:



Electronics module after encapsulation

Materials:

1. Copper-clad polyimide: Cu/PV/Cu, 18/75/18 μ m, AP8535R, Dupont, Pyralux;
2. Bluetooth microcontroller: NRF52832, Nordic Semiconductor Co.;
3. Solder paste:
 - a. Indalloy 290, Indium Corporation;
 - b. SMDLTLP, Chip Quick Co.;
4. Soft encapsulation silicone: Silbione RTV 4420, Elkem Co.;

Equipment:

1. EDA software: EAGLE 8.5, Autodesk Inc.;
2. Laser cutter: ProtoLaser U4, LPKF Co.;
3. Embedded software development platform: Keil uVision5, Arm Holdings;
4. CAD software: ProE Creo 3.0;
5. CO₂ laser: ILS12.75, Universal Laser Systems Inc.;
6. Milling machine: Roland MDX 540.

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1. Lu, W. , Bai, W. , Ge, Z. and Rogers, J. (2021). Design and fabrication of the electronic modules. Bio-protocol Preprint. [bio-protocol.org/prep899](https://doi.org/10.1101/2021.08.11.451899).
2. Lu, W., Bai, W., Zhang, H., Xu, C., Chiarelli, A. M., Vázquez-Guardado, A., Xie, Z., Shen, H., Nandoliya, K., Zhao, H., Lee, K., Wu, Y., Franklin, D., Avila, R., Xu, S., Rwei, A., Han, M., Kwon, K., Deng, Y., Yu, X., Thorp, E. B., Feng, X., Huang, Y., Forbess, J., Ge, Z. and Rogers, J. A. (2021). Wireless implantable catheter-type oximeter designed for cardiac oxygen saturation . Science Advances 7(7). DOI: [10.1126/sciadv.abe0579](https://doi.org/10.1126/sciadv.abe0579)

